Pest Management Alliance Project Final Report

Year 5

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Table of Contents

List of Figures & Tables

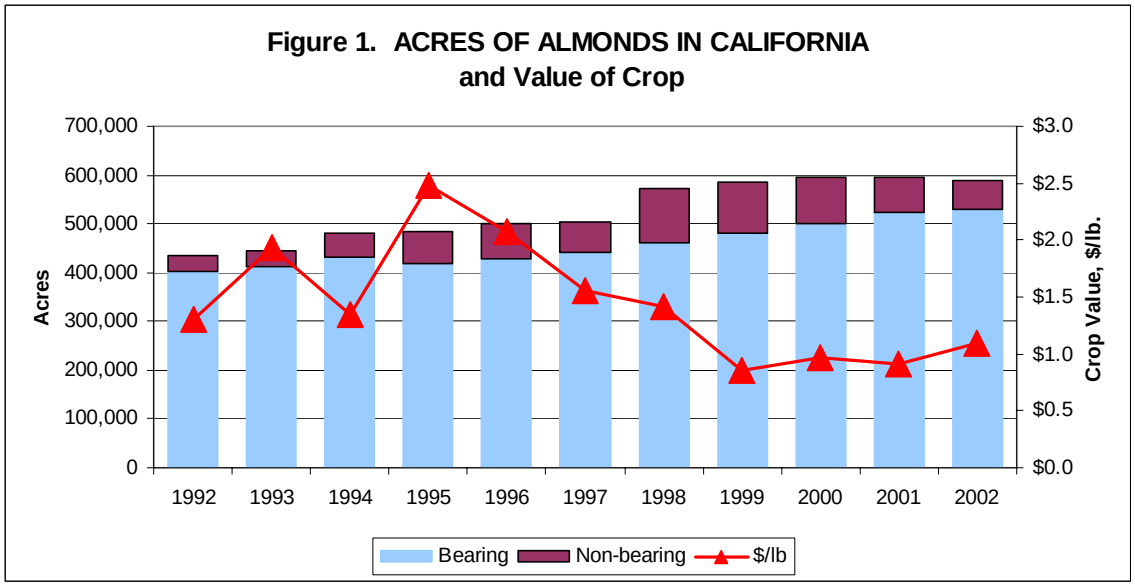
Figure 24	Total pesticides applied to almonds in California		43

Almond Pest Management Alliance Final Report 2003

EXECUTIVE SUMMARY

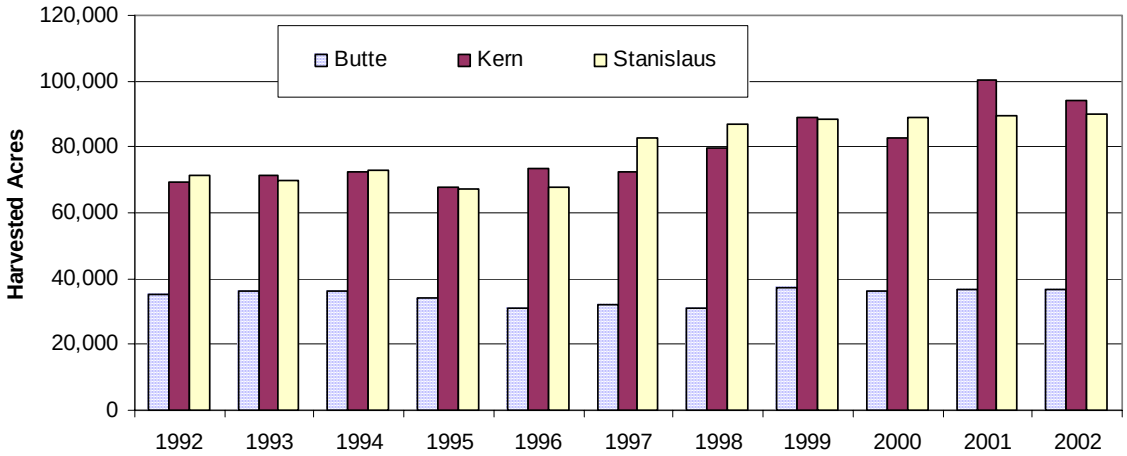
The Almond Pest Management Alliance (PMA) was initiated by the Almond Board of California in 1998 to evaluate the possibility of reducing the pesticide inputs in California Almonds. The Almond Board of California initiated discussions among the industry stakeholders to look at the possibility of forming a cooperative effort. Working closely with the Almond Hullers and Processors Association, the Community Alliance with Family Farmers, the University of California Statewide IPM Project, and University of California Cooperative Extension, an alliance was formed to pursue a grant available from the California Department of Pesticide Regulation to study reduced risk practices in California almonds. This collaborative approach grew out of two major concerns. Those two concerns are the implementation of the Food Quality Protection Act (FQPA) with possible loss of some traditional crop protection tools and growing public concern over water quality standards in the San Joaquin River and Sacramento River watersheds, with possible links to pesticides used by almond growers.

The Almond PMA's five years of successful reduced risk research and demonstration illustrate that almonds can be grown using a "soft" pest management program without additional damage to the crop. During this time (Almond PMA 1999-2003), the California almond industry has reduced its annual use of pesticides by almost 3 million pounds, which is a 20% reduction in pounds applied/acre, showing a true commitment by the Almond industry, the University, and the almond growers. Yields and quality have remained high, with production in 2002 at a record of over one billion pounds. Although prices have been in a general decline for the last seven years, in 2002 the crop value was over $1/lb for the first time since 1998, Figure 1.



Because of the enormous scope of the California almond industry which encompasses approximately 590,000 acres, ranging from Bakersfield to Chico, and the wide range of pests and regional variables, the PMA set up and continues to use the three regional projects. These projects are located in the Northern Sacramento Valley (Butte County), the Central San Joaquin Valley (Stanislaus County) and the Southern San Joaquin Valley (Kern County). Each project consists of an orchard that is divided into conventional practice treatment blocks and various reduced risk treatment blocks. Each project is directed by the local UCCE farm advisor and addresses regional pest concerns and growing conditions that would be relevant to local growers. The almond industry is closely examined in the three project areas as well as statewide, Figure 2.

Figure 2. Acres of Almonds in Butte, Kern, and Stanislaus Counties



The advisors employ a field scout who performs the extensive monitoring required .The target pests addressed across all three projects continue to be navel orangeworm (NOW), peach twig borer (PTB), San Jose scale, mites, and ants. Diseases, cover crops, and fertilizer applications are studied on a regional basis. Smaller satellite projects compliment the PMA orchard demonstration sites by providing research about regional issues.

In conjunction with the three regional project sites, the other components of the Almond PMA are to work closely with the Advisory team to stay abreast of current industry issues throughout the year, and to define research needs as they arise. In addition, an examination of the pesticide use reports each year to determine the almond industry's contribution to the total pesticide load in the three regions of the project as well as the whole state. However, the most important part of the project may be to extend the most current information through field meetings and mailings such as newsletters.

In conclusion, the five years of the Almond PMA have demonstrated the following:

1. Extensive orchard monitoring is the key to the success of reduced risk pest management. Regular monitoring provides a real-time picture of pest levels and helps to determine necessity and timing of treatments.
2. Reduced risk practices appear to be controlling the pests below economic damage levels.
3. Other pests or beneficial organisms may begin to build populations due to the altering of spray programs. With the reduction of full-spectrum insecticides, secondary pests and beneficials may appear in greater numbers.
4. Growers in the Almond PMA have made an unselfish commitment to continue to study reduced risk programs by remaining in the PMA for five continuous years.

These growers can lead by example, encouraging others to implement reduced risk systems.

5. Growers are interested in reduced risk practices and continue to be proactive, as shown by increasing attendance and participation in outreach activities that emphasize reduction of broad spectrum pesticides in almonds.

Overall, we can conclude that outreach is critical regarding adoption and implementation of reduced risk practices. The University of California involvement is important to ensure scientific credibility. The success of the PMA project essentially rests on the growers and PCA's who are willing to be innovative and take risks in order to give reduced risk practices validity. Future goals of the Almond PMA are to:

- Involve and train more PCA's and growers in monitoring during the crop season and through the dormant season.
- Create regional guidelines for reduced risk pest management in almonds based on what has been learned in the PMA project.
- Continue regional projects long-term to monitor for changes in pest pressures and to verify the ability of reduced risk practices to continue to keep crop damage at a low level.

INTRODUCTION

The first year of the Almond Pest Management Alliance (PMA) was funded by a $99,000 grant awarded by the California Department of Pesticide Regulation (CDPR) for the crop year Aug. 1, 1998 to July 31, 1999. The title is "To Promote a Reduced-Risk System of Almond Production Through Alternative Practices." Since then, four more years of research and demonstration have been funded by the CDPR PMA grants with additional funding from the Almond Board of California.

Structurally, the Almond PMA is managed by a team composed of representatives from each of the identified organizations, as well as private Pest Control Advisors (PCA's.) This Advisory Team meets several times yearly to review the project's progress and make decisions about its future course. The Almond Board of California oversees the administrative functions.

The Almond PMA set these basic objectives at the beginning and they continue to be relevant through subsequent years of funding.

- Establish orchard sites in three different almond-growing regions to collect data regarding almond pest management practices that reduce environmental risks associated with pesticide use.
- Conduct extensive orchard monitoring and specific research activities that address localized pest control and almond production practices.
- Provide almond growers with updated information on available reduced risk pest control practices so they can make informed choices about alternatives.
- Promote and extend information to growers to ensure California almond growers understand the need for a reduced risk system that has the ability to reduce pesticides and sustain profitability.
- Evaluate the risk reduction achieved as a result of this project by producing a final report that includes not only a projection of the risk reduced, but a discussion of the costs and benefits of the solution and the practicality of adoption.

To compliment the objectives involved in the Almond PMA, tasks were designed to accomplish the goal of reducing pesticide use. Task 1 is to assemble an Advisory team that provides direction and keeps the project moving forward. Tasks 2 through Task 4 consist of the continuation of the PMA sites in Butte, Kern, and Stanislaus counties respectively. Task 5 is to research pesticide use in each of the regional PMA sites. Outreach and education to the growers are Task 6, being field meetings, newsletters, and news articles relating to the Almond PMA. Finally, Task 7 is the project evaluation.

The PMA views this project as an efficient way to bring together many years of research and demonstration which have been spent on alternative and reduced risk management techniques. By applying the vast body of knowledge accumulated over the years by the University of California the Alliances goal is to study reduced risk practices on a large scale.

The Almond Board of California has been supporting an Integrated Pest Management (IPM) system for more than 25 years. These projects have helped reduce the use of pesticides through such studies as: Navel orangeworm Orchard Sanitation and Early Harvest, Reducing Dormant Spray Hazards, Pheromones for Peach twig borer, and Alternatives for Soil Fumigation with Methyl Bromide. Results of these research projects are available from the Almond Board of California. The Board has also received an "IPM Innovator Award" from CDPR for its innovative leadership role in the field of IPM.

The UC Statewide IPM Project is well recognized for its national leadership on IPM. The IPM Project publishes the well-respected *IPM for Almonds Manual.* This publication states, "A good IPM program coordinates pest management activities with cultural operations to achieve economical and long-lasting solutions to pest problems." The PMA has taken this quote to the field and reduced risk farming practices take in cultural and long-lasting solutions seriously.

Task 1: Almond PMA Advisory Team

Task 1 is the planning and leadership by the Almond PMA Advisory Team. The Advisory Team is responsible for the cooperative decision-making which leads to the design and implementation of new methods to approach reduced risk practices. Communication between participating groups is important to achieve these results. The PMA Advisory Team meetings bring together representatives from the three almond growing regions to ensure local grower concerns are incorporated into PMA project plans.

The Advisory Team met on March 11, 2003 in Modesto, at the offices of the Almond Board of California. The 8 Team members reviewed the 2002 PMA projects in the three regions: Kern, Stanislaus, and Butte Counties. Tentative dates for the spring field days were discussed as well as possible topics and presentations. Ideas for articles to include in the Almond PMA Spring newsletter were considered. Also discussed were possibilities for the future of the PMA project after the 5th year, when funding from CDPR is no longer available. It was agreed that the PMA has been successful on several levels, and funding options will be pursued to continue the project on a smaller scale. The Advisory Team met again on September 23, also in Modesto. Larry Wilhoit presented a data from the Pesticide Use Reports showing decreases in dormant OP use in almonds by county and statewide. The Almond Grower Mail Survey results were summarized and updated by Sonja Brodt and Frank Zalom, and a draft form was distributed. Planning for the dormant season field days and for a five-year project summary were also discussed. The importance of continuing the PMA was again brought up, to demonstrate successes growing almonds using reduced risk products and integrated pest management. There are several possibilities for publishing guidelines for producing almonds based on what was learned from the PMA. The Team emphasized publications based on the different pest pressures in the different growing regions of the state.

The Advisory Team leadership is essential for the success of the Almond PMA by providing direction and expertise. Each of the almond growing regions of California have issues specific to that area and the Almond PMA Advisory Team has realized that it must incorporate area-specific information in any publication or outreach.

Task 2:
Butte County Almond Pest Management Alliance
2003 Final Report
Year 5

Joe Connell, UCCE Farm Advisor, Butte County; Carolyn Pickel, Area IPM Advisor; Sara G. Smith, Field Scout, UC IPM; Nick Bertagna, grower; Richard Gregor, pest control advisor.

Butte County Objectives:

1. To scientifically evaluate the success and profitability of managing arthropod pests with less broadly toxic pesticides in a commercial almond orchard.
2. To demonstrate and facilitate adoption of integrated pest management monitoring techniques and decision-making processes to growers and pest control advisors.

This report summarizes our progress through the fifth year of the project. The Butte County site is an orchard of 49 acres and originally contained four different treatment blocks plus an untreated check of ½ acre added in 2001. The PMA I block is a "typical" soft treatment with *Bacillus thuringiensis* used for lepidopteron control, the OP Dorm block is treated with an organophosphate pesticide plus oil during dormancy, and the OP Dorm/HS block is treated with an organophosphate plus oil during hullsplit as well as during dormancy. The PMA II block is the grower's standard practice. However, no insecticide treatments (except for the section treated with Clinch ant bait) were applied to the PMA I in either 2001, 2002, or 2003 so it was the same as the untreated control. Starting in 2002, chemical inputs were reduced even more in the PMA II block (Grower Standard) with no further insecticide treatments ; making this orchard an excellent demonstration of the long term effects of an economically viable and environmentally friendly farming system. The two "OP" blocks mentioned above have received a dormant application each year, and the OP Dorm/HS block received an insecticide at hullsplit every year except 2002. Pest control has been supplemented with three species of beneficial insects released by a private Pest Control Advisor, Richard Gregor. In 2003, a satellite trial was conducted in portions of the PMA I and OP Dorm blocks. These were treated with a reduced risk ant bait for comparison purposes. The entire orchard was treated with a reduced risk fungicide and also an herbicide for weed control. Treatment details for 2003 are as follows:

1. PMA I and PMA II, 39 acres total. Grower's standard practices- no insecticide sprays applied.
2. OP Dorm, 5 acres. Diazinon (4 pts/acre) plus oil (4 gal/acre) applied mid January.
3. OP Dorm/HS, 5 acres. Diazinon (4 pts/acre) plus oil (4 gal/acre) applied mid January, and Imidan (5 lbs/acre) applied at hullsplit July 19.

Clinch ant bait was applied on July 21, after sampling to determine the areas with the highest population. The treatment area was approximately the eastern 8 acres of the PMA block and the eastern 3 acres of the OPD block, for a total of about 11 acres. The application rate was about 0.9 lbs per acre and was applied with a spreader specifically for use with Clinch.

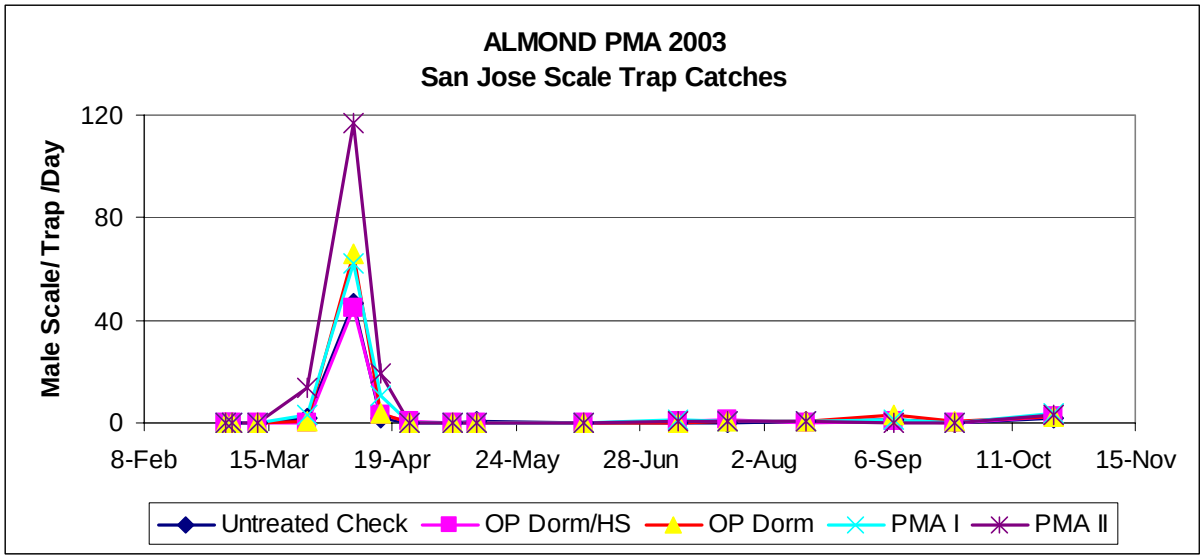
Beneficial insects were released evenly throughout the orchard, in all the treatment blocks, starting in April 2003. Lacewing species, *Trichogramma* species, and *Goniozus legneri* were released approximately every week throughout the summer until harvest. Fungicide treatment and weed management was the same across the whole orchard, with two applications of Vanguard @ 5 oz/acre, one each in February and March. Herbicide was applied to the strip (in the tree row) in April and July with Roundup @ 2 pints/acre

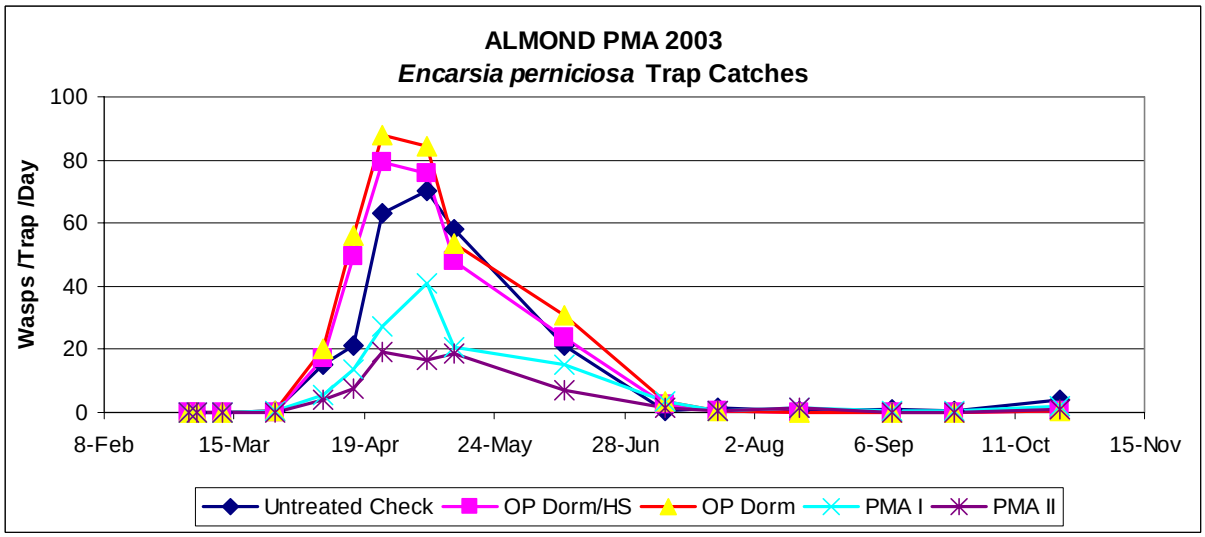
and Goal @ 5.5 oz/acre. The middles were treated in August and September with Roundup @ 3 pints/acre. Additional weed control was achieved by mowing. The orchard floor was mowed every other row 6 times.

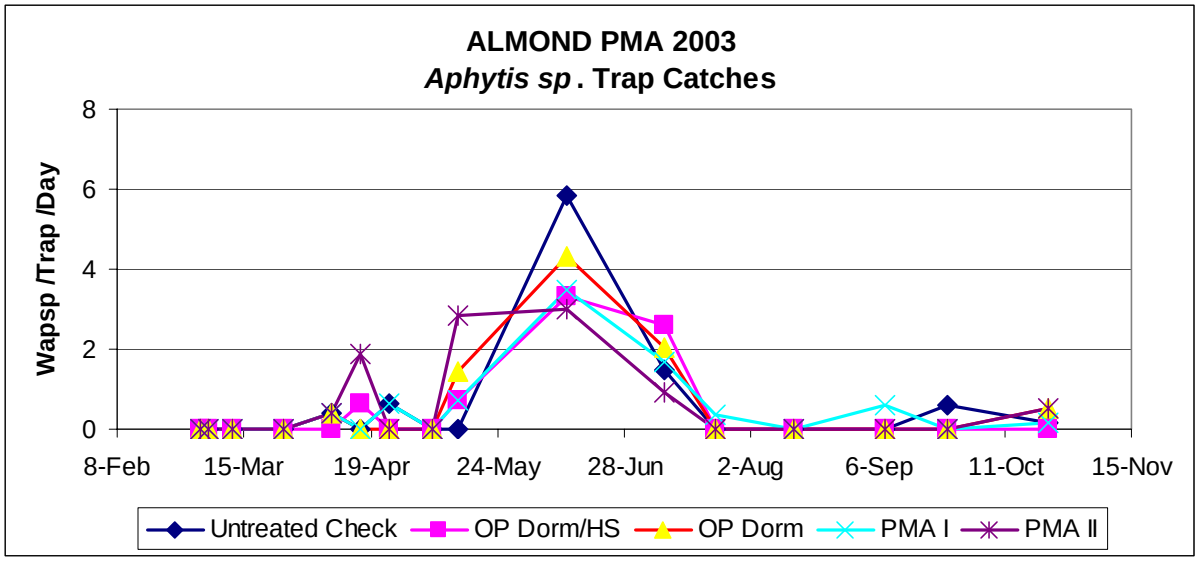
Monitoring:

This trial is monitored for peach twig borer, naval orangeworm, web spinning mites, San Jose scale adult males, and San Jose scale parasitoids (*Encarsia* and *Aphytis*), and ants from late winter through October. In each treatment pheromone traps were placed in the center of the block and monitored weekly for peach twig borer and San Jose scale. Naval orangeworm is monitored with an egg trap baited with almond meal.. Lures and bait were changed as recommended by the manufacturer. Weekly trap counts were shared with growers, Farm Advisors, and PCA's. Degree days for each of these pests were calculated to determine biofixes and to provide treatment timing for those in the area who might need it. Weather data and degree day calculations were obtained at no cost from www.Fieldwise.com using the Durham station. Beginning in June, plots were monitored every other week for mites using the presence / absence sampling technique. Each treatment block was surveyed for shoot strikes in June and in July. Sampling for ants took place in Mid July using the hot dog baiting method.

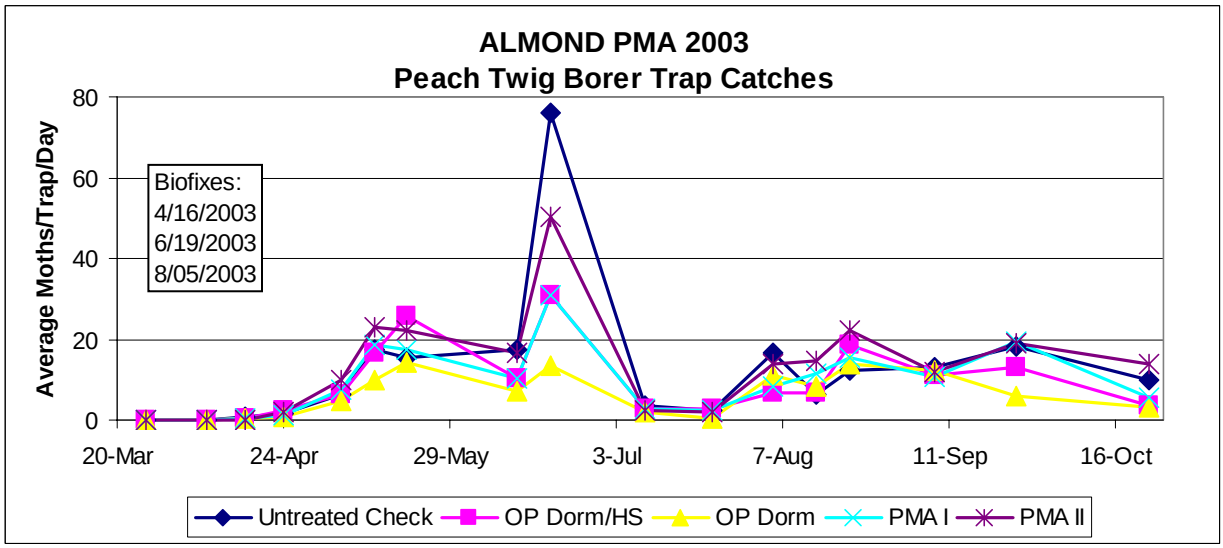
San Jose scale pheromone traps were placed in the orchard on February 21 and checked weekly for the presence of male scales. The SJS traps were also checked for parasitic wasps of the scale, *Encarsia perniciosi* and *Aphytis species* which are also attracted to the SJS lure and get stuck on the trap. The first scales were found in the traps March 26 and increased dramatically on April 8, which turned out to be the highest population all season. After this date, the male scale reappeared sporadically in low numbers all season. Parasitoids were also detected on the traps beginning March 26 and were most always present whether or not scale was caught on the traps. The peak population of *Encarsia* occurred on April 24, and *Aphytis* catches were highest on June 12 as shown in the three graphs below.


ALMOND PMA 2003
San Jose Scale Trap Catches
Male Scale/ Trap /Day
120
80
40
0
8-Feb
15-Mar
19-Apr
24-May
28-Jun
2-Aug
6-Sep
11-Oct
15-Nov
Untreated Check
OP Dorm/HS
OP Dorm
PMA I
PMA II


ALMOND PMA 2003
Encarsia perniciosa Trap Catches
Wasps /Trap /Day
100
80
60
40
20
0
8-Feb
15-Mar
19-Apr
24-May
28-Jun
2-Aug
6-Sep
11-Oct
15-Nov
Untreated Check
OP Dorm/HS
OP Dorm
PMA I
PMA II



PTB pheromone traps were hung March 26 and checked twice a week to establish the first biofix. The weather data and degree day modeling available on the UC IPM website http://www.ipm.ucdavis.edu/index.html, used in conjunction with actual trap catches helps to identify the biofixes during the season.



The upper portion of the canopy was inspected for shoot strikes (SS) at the beginning of PTB generations. Five trees per treatment block were examined. Shoots with damage were clipped with a pole pruner and split down the center to verify presence and identification of larvae. In previous seasons, few if any shoot strikes were ever found, making the high level of strikes found in 2003 unusual. When larvae were present, they were identified, but if the strike was already vacated, no attempt was made to determine

whether the damage was done by Peach Twig Borer or Oriental Fruit Moth. The following data was collected on June 12, 2003:

Treatment	**# SS/tree**	**% SS with no worm**	**% SS OFM**	**% SS PTB**
Orchard Average	3.1	85	82	18
No Dormant	4.4	80	63	37
Dormant	1.9	88	100	0

In 2003, much higher SS counts occurred in all of the treatment blocks. From 1998 through the 2002 season, shoot strike counts were never more than 1 per tree. In most years we would find only one or two shoot strikes in each block. In spring 2003, the dormant spray treatment had 1.9 shoot strikes per tree which was less than the 4.4 strikes per tree in the no dormant spray treatment. None of the shoot strikes in the dormant treatment were PTB and the shoot strikes in the no dormant treatment were predominately OFM.

The Naval Orangeworm egg traps were filled with ground almond bait and placed in each treatment block on April 8. Due to repeated rainy weather and molding of the almond bait, the traps were removed, refilled, and replaced on May 13. The only NOW eggs found on the egg traps all season were in the week of September 8, when there were 8 eggs on the trap in the Untreated check, and 5 on the trap in the PMA I block.

Cumulative trap catches through October 23, 2003 for peach twig borer, San Jose scale males, *Encarsia*, *Aphytis*, and naval orangeworm eggs for the four treatments and check are listed below. It is worth noting that both PMA I and II had zero sprays of organophosphates, the OP Dorm block had one spray, and the OP Dorm/HS block had two insecticide sprays.

ALMOND PMA 2003 Cumulative Trap Catches					
	NOW	PTB	SJS	*Encarsia*	*Aphytis*
Untreated	8	2537	750	2955	240
OP Dorm/HS	0	1747	735	3320	180
OP Dorm	0	1266	1065	3855	215
PMA I	5	1896	1140	1680	190
PMA II	0	2655	1995	905	170

In previous years, ants were monitored to determine species present in each of the treatment blocks, but no attempt was made to quantify the ant populations. The species found in the orchard were Southern Fire Ant and Pavement Ant. The harvest samples

from 2001 and 2002 were damaged mostly by ants even though the damage level was very low.

Therefore, ant sampling was conducted in both 2002 and in 2003 to measure population levels and densities of ants throughout the entire orchard. Vials were numbered, baited with pieces of hot dog and placed, open, at the base of every 15th tree. This was done in every fifth row. The vials were capped, collected, and frozen after 1.5 hours. Later, the vials containing ants were counted to determine whether any areas of the orchard would have to be baited for ant control. The data, following, shows a range of population densities which could be due to location in the orchard. The data also shows an increase in the ant populations since last year in all areas of the orchard, hence the treatment decision described near the beginning of this chapter.

ALMOND PMA 2003 & 2002 ant Sampling Results					
TREATMENT BLOCK	# VIALS With ANTS	# VIALS	% ANTS 2003		% ANTS 2002
CHECK	2	6	33.3		-
OPD	12	12	100.0		64
OPD/HS	7	11	63.6		27
PMA I	15	19	78.9		65
PMA II	33	51	64.7		40
WHOLE ORCHARD	69	99	69.7		48.2

Dormant spur sampling is conducted before the growing season begins, most recently on Jan 15, 2004. Spurs were taken from each treatment block and inspected for mite eggs, predatory mites, San Jose scale, parasitized SJS, and European Fruit Lecanium crawlers. Counts were tabulated and compared to the four previous years of the PMA project to determine if levels are increasing or decreasing and if the treatment threshold for any of the listed insects had been reached. Dormant spur sampling has continued in this orchard beyond the five years of the PMA for use in future research projects, for a total of six years of dormant sampling data.

ALMOND PMA 2003 Counts from Dormant Spurs for Six Consecutive Years

	Date	PMA II	PMA I	OP Dormant	OP Dorm. & HS
Mite Eggs	12/7/1998	68	69	54	53
	12/3/1999	17	18	8	8
	12/8/2000	4	2	3	7
	1/3/2002	3	2	6	9
	1/8/2003	2	0	0	0
	1/16/2004	2	0	0	0
SJS (Live)	12/7/1998	5	2	0	6
	12/3/1999	15	11	3	3
	12/8/2000	5	1	1	2
	1/3/2002	5	9	0	1
	1/8/2003	7	5	1	2
	1/16/2004	6	4	2	0
Parasited SJS	12/7/1998	0	0	0	0
	12/3/1999	5	6	0	1
	12/8/2000	2	1	0	0
	1/3/2002	0	0	0	0
	1/8/2003	1	0	0	0
	1/16/2004	3	1	0	0
EFL Crawlers	12/7/1998	N/A	N/A	N/A	N/A
	12/3/1999	8	15	0	0
	12/8/1999	10	0	0	0
	1/3/2002	10	7	0	1
	1/8/2003	1	6	2	2
	1/16/2004	9	11	10	1
Predator Mites	1/3/2002	1	0	0	1
	1/8/2003	0	0	0	0

This orchard has had evidence found in the dormant spur sample of parasitism of the San Jose scale and also of the European Fruit Lecanium.

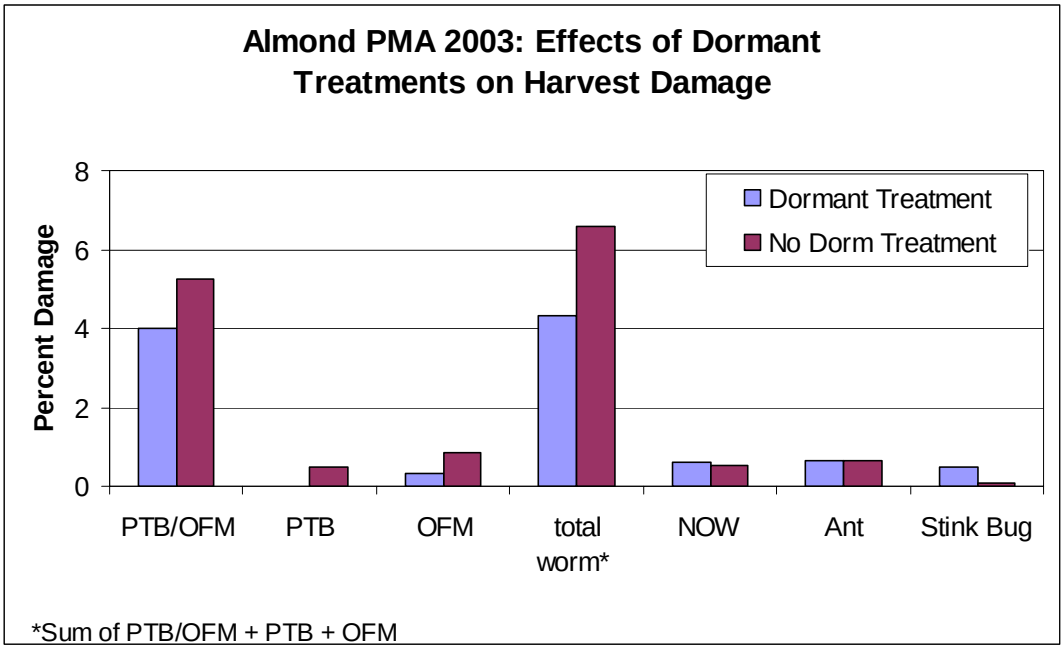
Harvest Reject Levels

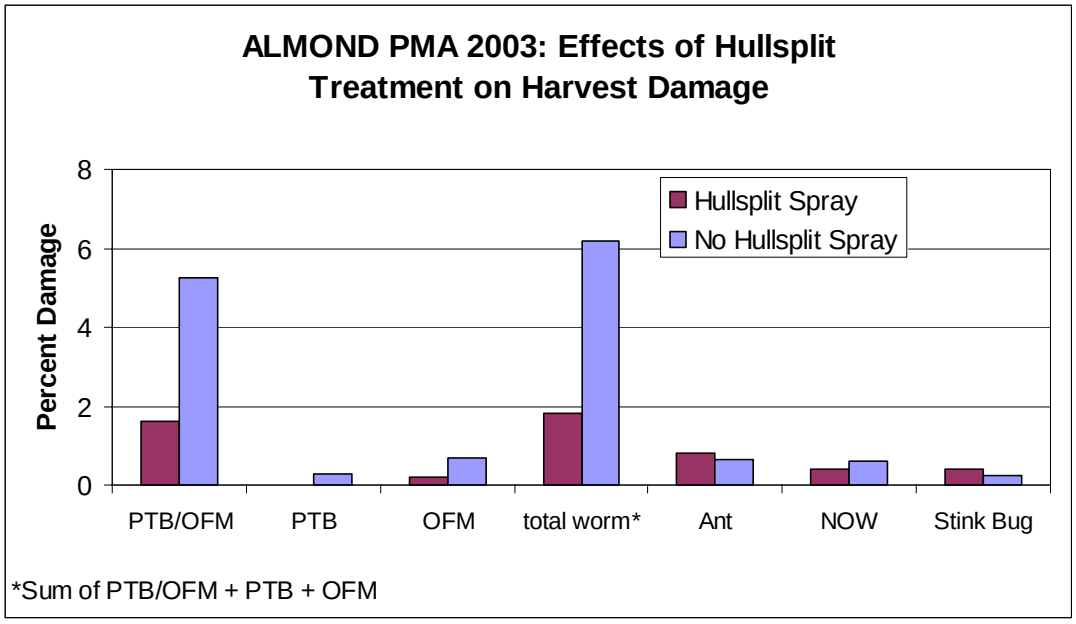
At harvest, 100 almonds were randomly collected from each of five trees in each of the treatment blocks for a total of 500 per treatment. Due to the portions of the orchard blocks treated with Clinch bait for ants, additional samples were collected for ant damage comparisons. Nuts were inspected for damage, and an attempt was made to identify the insect which had caused the damage. It is difficult to distinguish OFM from PTB worm damage to the nut, if no larvae or pupae parts were found, it was classified as "PTB/OFM". Percent damage to each treatment block was calculated. This year, the harvest sample contained more insect damage than any of the previous years of the Almond PMA, a situation which was seen throughout the state. The Harvest Damage Table is expressed in percent damage.

Percent Damage at Harvest. Almond PMA 2003

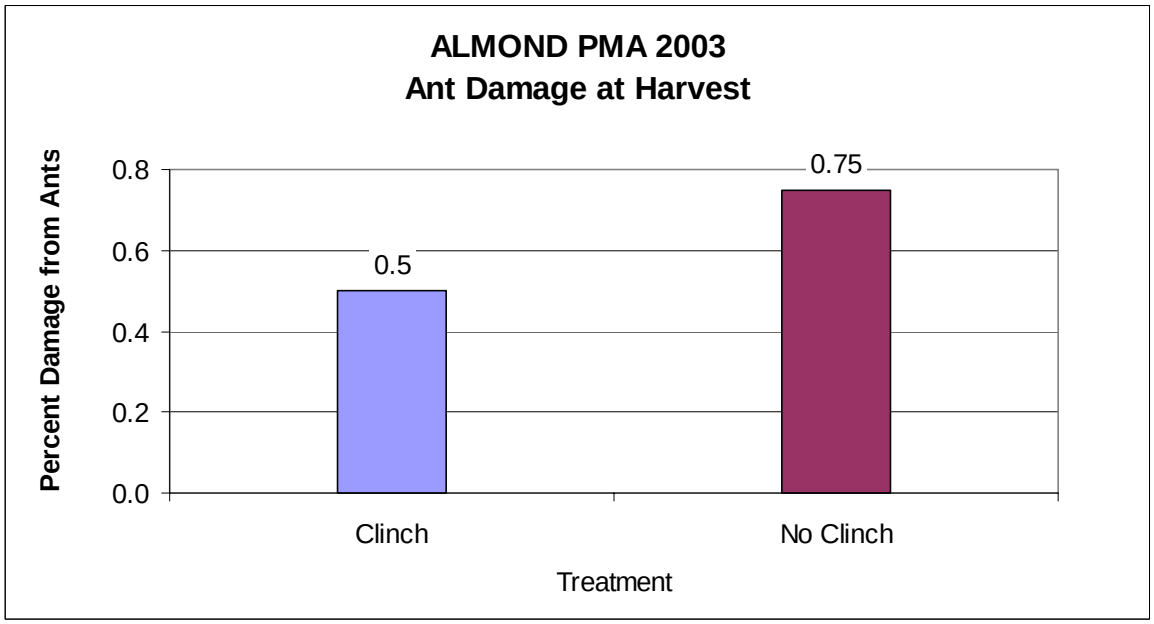
	PTB/OFM	PTB	OFM	NOW	Ant	Stink Bug
PMA I	5.0	0.2	1.8	0.8	0.8	0
PMA II	6.0	1.2	0	0.8	0.8	0
OPDorm	8.0	0	0.2	1.4	0.6	1.4
OPDorm/HS	1.6	0	0.2	0.4	0.8	0.4

The blocks with and without dormant insecticide treatments were compared, in the first graph below, for peach twig borer (PTB), oriental fruit moth (OFM), stink bug, navel orangeworm (NOW), undifferentiated worm damage (PTB/OFM), and total worms (sum of OFM/PTB+PTB+OFM). The dormant spray treatment reduced the amount of PTB damage but had little effect on OFM damage. It also did not reduce stink bug, navel orangeworm, or ant damage. It is clear from this data that a dormant spray would have only reduced the rejects by a small amount. There were no treatments receiving only a hull split spray. Comparing damage in the treatment receiving dormant plus hull split insecticide sprays versus treatments receiving no hull split spray in the second graph below, it can be seen that the hull split spray reduced the PTB, OFM, NOW, and total worm damage. The hull split treatment did not reduce ant or stink bug damage.





Although damage from ants was again less than 1% in 2003, we saw less damage in the Clinch-treated area, as shown below.



Costs Associated with Almond Pest Management Programs

The costs of the different insect pest management programs are discussed below. Fungicide and weed control are the same throughout the entire orchard, so are not compared in the table below. The beneficial insect releases were covered by the PCA's flat rate of $43/acre. The plots with an application of Clinch are listed separately from the main treatment blocks to separate out the additional cost.

ALMOND PMA 2003 Pest Control Treatments

	Timing	Material	Materials $/acre	Application $/acre	PCA $/ac	Total $/acre
PMA I	-	-	-	-	43.00	43.00
PMA I +Clinch	July 21	Clinch	13.00	-	43.00	56.00
PMA II	-	-	-	-	43.00	43.00
OP Dorm	Dormant (Jan)	Diazinon + Oil	9.00 20.00	18.00	43.00	90.00
OP Dorm	Dormant (Jan)	Diazinon + Oil	9.00 20.00	18.00	43.00	103.00
+ Clinch	July 21	Clinch	13.00			
OP Dorm/ HS	Dormant (Jan)	Diazinon + Oil	9.00 20.00	18.00	43.00	153.00
	Hullsplit (July 19)	Imidan	45.00	18.00		

Treatment costs are meant to represent an average grower in this area. Prices for materials are from the 2003 UC publication *Sample Costs To Establish An Almond Orchard And Produce Almonds* in the South San Joaquin Valley because it is the most recent and up to date cost study. Application costs for the orchard sprayer are directly from the grower to more closely represent the region, and include labor, fuel, lube and repairs. The treatment block that received treatments at dormant and at hullsplit is by far the most expensive, but it also had much less damage from PTB due to the hullsplit spray. Most years the worm damage is very low in all blocks, but in 2003, the hullsplit spray reduced worm damage to 1.6%, and the other blocks without a hullsplit treatment averaged 6.33% damage from worms (OFM / PTB).

Conclusions

Historically, the Butte County Almond PMA has been quite successful in showing that there is no more pest damage in the PMA blocks which had zero pesticide applications, than there is in the treatments with organophosphate sprays. Clearly, in 2003 we had the highest population of OFM that we have seen in 5 years of monitoring this orchard. We suspect that these high populations along with the unusually cool weather allowed OFM to feed in the green nuts resulting in unexpected damage. A prophylactic hull split spray was applied in July to one treatment in the Butte Almond PMA orchard and it resulted in the lowest worm damage this year. The subsequent unseasonably cool weather conditions also delayed harvest which undoubtedly contributed to an increase in all types

of damage. The unusual circumstances that led to damage this year would have been difficult if not impossible to anticipate. It is unlikely that the ongoing expense of annual hull split insecticide treatments (which have not shown benefits in this orchard in previous years) could be justified on the basis of these relatively rare events.

Our spring field day and winter dormant meeting were well attended and interest in adopting reduced risk practices remains in the forefront for growers. The outreach and education portion of this project emphasizes that the key to successful reduced risk practices is intensive monitoring. We will continue to monitor to follow insect populations to see what if the unusual pest pressures of 2003 will be repeated. The Almond Pest Management Alliance has been active for five years in California. Interest in reduced risk farming practices has increased as the economic viability of the methods has been demonstrated. The PMA demonstration in Butte County has been beneficial for growers, industry, and the environmental and regulatory community.

Task 3:

Kern County Pest Management Alliance Project Year 5 Final Report

Mario Viveros, Walt Bentley,
Peggy Schrader and Minerva Gonzalez

Introduction:

The purpose of this project was to demonstrate a reduced pesticide input versus a conventional pesticide management program in young orchards for the Southern end of the San Joaquin Valley. This project was established five years ago in a 160 acre block which was made up of 80 acres of "hard shells" (Butte – Mission – Padre) and 80 acres of "soft shells" (Nonpareil – Fritz – Sonora). Both "hard and soft" shell varieties were divided into two (20 acres each) conventional and two (20 acres each) reduced input management plots. For the 2001, 2002, and 2003 season each of the plots in both conventional and reduced input were divided into dormant and non-dormant spray subplots. This is to say we now have the following treatments: 1) conventional dormant, 2) conventional non-dormant, 3) reduced dormant, and 4) reduced non-dormant.

This report is for data obtained in the 2003 season. It doesn't include information from 1999, 2000, 2001, and 2002 seasons.

Cover Crops:

The barley cover crop has been selected because of the saline-alkali and poor drainage conditions of the PMA orchard soil. The barley was seeded in every middle on one of the 20 acres soft shell blocks. The planting was done in December at a rate of 80 lbs per acre. Due to the late rains, there was a good seed germination.

Pest Monitoring:

The setup for pest monitoring was similar to the one we used in 2002. The reason being that both conventional and reduced input management treatment was subdivided into dormant and non-dormant subplots.

San Jose Scale (SJS). This pest was monitored using twig samples, pheromone lures and double-sided sticky tape. The overwinter population on fruiting wood was monitored in December. Twenty spurs were gathered from each block, concentrating on the susceptible varieties, Padre, Sonora and Thompson. Ten spurs were gathered low and ten high on the tree. The fruiting wood was again evaluated in March taking five twig samples in each treatment. The adult population was monitored by placing one sticky trap with a pheromone lure in each plot. The trap was placed on the tenth tree in from the end, and six or seven feet high in the northeast quadrant of each tree. The trap was placed on February 11 and was monitored weekly until the end of November.

Pheromone lures were replaced every four weeks. Adult San Jose moths were counted as well as the *Encarsia* and *Aphytis* adults. The crawlers were monitored by using double-sided sticky tape which was placed in four trees surrounding the tree that contained the pheromone traps. Tape was placed March 29, 2002 and was monitored weekly for presence-absence over the course of the season.

Peach Twig Borer (PTB). This pest was monitored by placing pheromone traps and by larva emergence from hibernacula. The traps were used for monitoring the adult population. They were placed in the tenth tree in from the end, six or seven feet high in the northeast quadrant of the tree. The traps were placed March 21, 2003 and their pheromone lures were replaced every eight weeks.

The PTB larvae emergence was determined by collecting rust-colored hibernacula (minute chimney-like piles of frass and sawdust) from crotches (branch angles) of two year old trees. With a grafting knife, a pie-shaped wedge containing the hibernacula was cut from tree crotches and placed into a vial. Ten hibernacula were collected from 10 different areas of an orchard located 9 miles from the PMA orchard. Under the microscope, the hibernacula was opened with a probe and the presence or absence of the larvae was noted. Absent larvae meant it had emerged. Therefore emergence was determined by the number of absent larvae. Samples were taken, every five days, from January 30 through March 17.

Navel Orangeworm (NOW). This pest was monitored with egg traps and winter sanitation. One NOW egg trap was placed in each plot on March 21, 2003. It was placed in the tenth tree in from the end in the north side of the tree and six or seven feet high. The traps were black and contained an almond meal mixture.

Winter sanitation was evaluated on February 12, 2003 by counting the number of nuts left from harvest. These nuts are called mummies. Forty-five trees in each plot were selected and the number of mummies were counted in each tree.

Mites. This pest was monitored with soil and leaf samples. The soil samples were taken in the winter and leaves were sampled during growing season. Soil monitoring to determine the overwintering female web spinning mite began February 10, 2003 and continued with weekly samples until March 26, 2003. Soil samples were taken from the base of the trees and placed in eight ounce Styrofoam cups which were filled to the rim. Then, they were placed on a sticky card and left at room temperature for two weeks. After two weeks, the overwintering female mites emerged from the soil and got stuck to the cards. The sticky cards were then read and the overwintering female mites were recorded.

Leaf monitoring for mites on Nonpareil and Butte varieties began on April 2, 2003. Leaf samples were taken at random from five trees in each plot. The tree location changed every week. Ten leaves were selected from each tree. Initially, only interior leaves were selected, however, by mid-May, half of the leaves were selected from the interior and half from the exterior of the tree. Leaves were brought back to the lab, in an ice chest,

and examined under a microscope. The presence-absence method was used. Only web spinning mites were considered. European red, predatory mites and sixspotted thrips were noted.

On March 26, 2003, twigs were selected from trees to evaluate the movement of overwintering females. Five twigs were gathered from five different trees in each plot. Twigs were selected from inside of major branches and only the lower parts of the branches were sampled. The twigs were brought back to the lab and examined under a microscope.

Ants. This pest was monitored by the "hot dogging" method on May 14, June 27, August 11 and October 31, 2003. Half-inch hot dog slice (Bar-S brand containing beef, pork, and chicken) was placed in a snap-cap vial. These vials were distributed in the orchard in the morning when ant activity is at its maximum. The vials stayed on the orchard floor for a period of two hours, then picked up and stored in the freezer until counting. The ants were removed from vials by washing them on to a petri dish. The ants were separated with a glass rod and counted.

Nutrients. The nutrient levels were monitored by June-July leaf samples. The samples were washed in distilled water. They were allowed to dry and then ground through a Wiley mill. The samples were then sent to the ANR Laboratory at U.C. Davis for analysis.

Production. Yields of Nonpareil and Butte from both conventional and reduced input systems were taken at harvest. In addition, yields were taken from dormant and non-dormant sprayed plots from both conventional and reduced input systems. Furthermore, yields were also taken from the Fritz variety to evaluate yield's response to SJS infestation.

Treatments:

Dormant Sprays. The conventional and reduced input systems were subdivided into sprayed and non-sprayed. The conventional sprayed treatment was sprayed with five pints of Diazinon® plus six gallons of oil mixed with 200 gallons of water per acre. The reduced input treatment received six gallons of oil in 200 gallons of water per acre. The spray was applied December 18, 2003.

Winter Sanitation. By February 7, both conventional and reduced input treatment were mechanically shaken for mummy removal.

May Spray. This spray was skipped this year. The reason was due to the ineffectiveness of May sprays.

Hull Split Spray. This spray was done on July 11, 2003, at the on-set of hull split for the control of NOW. The conventional (dormant and non-dormant) was sprayed with Imidan® 5 lb per acre in 200 gallons per acre.

Mite Sprays. The conventional received the following treatment. Agri-Mek® (10.1 oz.) + 1% oil (4/30 and 6/11) then 2% oil in every middle (7/2). The reduced input was divided into predatory mite and no predatory mite treatments. In the predatory mite treatment, 2500 mites per acre were released May 13 and June 5. Oil at 2% was sprayed (6/16) every other middle then 2% oil was sprayed in every middle in July 2. The reduced input without predatory mite releases consisted of the following: Agri-Mek® (10.1 oz.) plus 1% oil sprayed May 13, two percent oil was sprayed every other middle in June 5, then a 2% oil was applied in every middle in July 2. Please note that all these sprays were applied with 200 gallons of water.

Ant Sprays. The conventional-dormant was sprayed on July 27 with 4 pt. Lorsban® in 100 gallons of water per acre. Reduced-dormant received 1.5 lb. Distance® per acre on June 19. The reduced-nondormant received one pound of Clinch® per acre on July 9. There was an untreated control.

Results:

San Jose Scale. The San Jose Scale continues to increase in the plots that were left unsprayed for three seasons. The populations exploded in the plots where no dormant oil was applied and a hull split organophosphate insecticide was applied for NOW control. Table 1 shows the percent of SJS infestation. The no dormant treatment shows the greatest percent of infested twigs with live SJS. The reduced input shows the least amount of SJS infestation. This may mean that the organophosphate insecticide applied at hull split may be affecting the natural enemies of SJS.

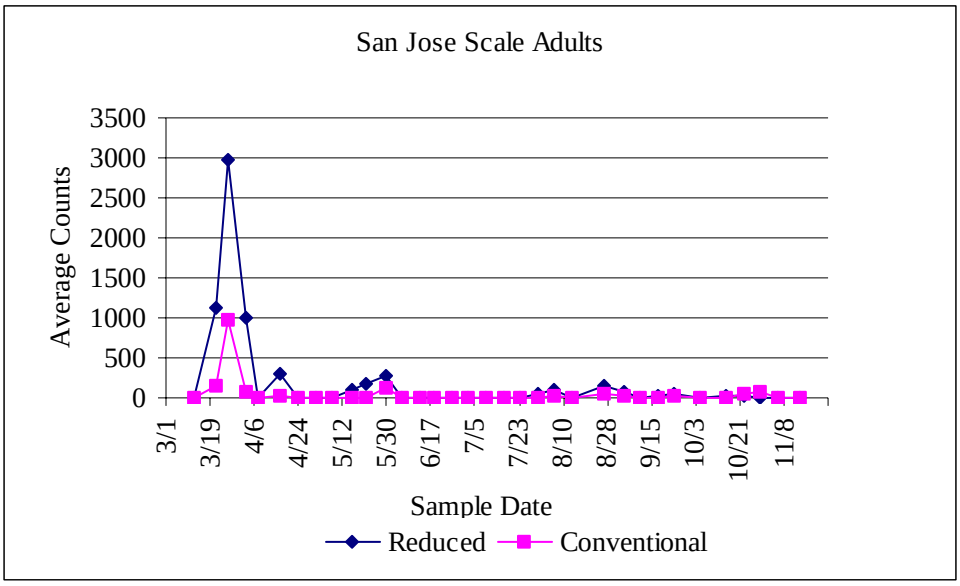
Table 1. Percent of twig infestation with both live and dead SJS in reduced input, conventional and no dormant treatments.

Treatment	SJS Infestation (%)		No Infestation (%)
	Live	Dead	
Reduced Input	1.2	24.8	74.0
Conventional	4.4	35.2	60.4
No dormant	32.5	21.2	46.3

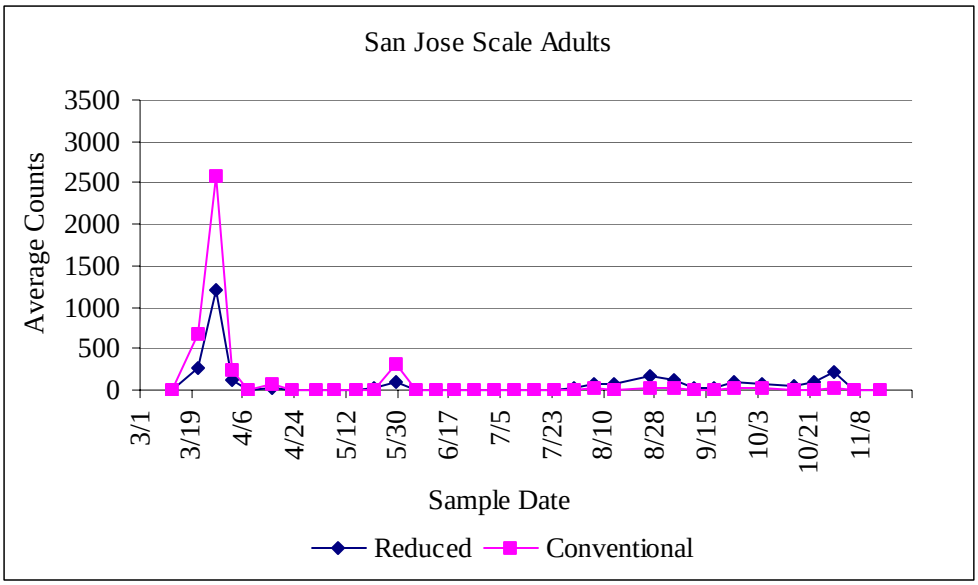
The SJS adult population from reduced and conventional treatments from plots that received dormant and no dormant oil sprays is found in Figure 1. The population was monitored from March to November. However, the only difference in the population is found in early March. Where no dormant oil was applied, we have a greater SJS population in the reduced input than on the conventional. This is expected since no dormant oil was applied. However, where a dormant spray was applied the reverse occurred. The conventional treatment showed a greater SJS population than the reduced treatment. This can be due to the effect of organophosphate spray at hull split. The spray

may have eliminated SJS natural enemies. SJS populations can be detected by using the adult traps. However, orchard infestation can be best determined by sampling spurs in the dormant season.

Figure 1. Average number of SJS adult males from reduced and conventional treatments from plots that received dormant and no dormant oil sprays.



No Dormant Spray



Dormant Spray

Peach Twig Borer. The PTB emergence in relation to air and bark temperature is found in Figure 2. The bark temperature is higher than the air temperature but both run parallel to each other. Furthermore, they don't appear to have an effect on the rate of emergence of PTB.

The rate of emergence coincides with bloom development. The beginning of Nonpareil bloom was February 12, at this time PTB emergence was 22%. PTB reached 80% in March 13, at this time Nonpareil was at the end of petal fall. When PTB emergence coincides with bloom, one can control bloom diseases and PBT by mixing a fungicide and Bt in the same sprayer's tank.

Figure 2. Peach Twig Borer emergence in relation to air and bark temperature.

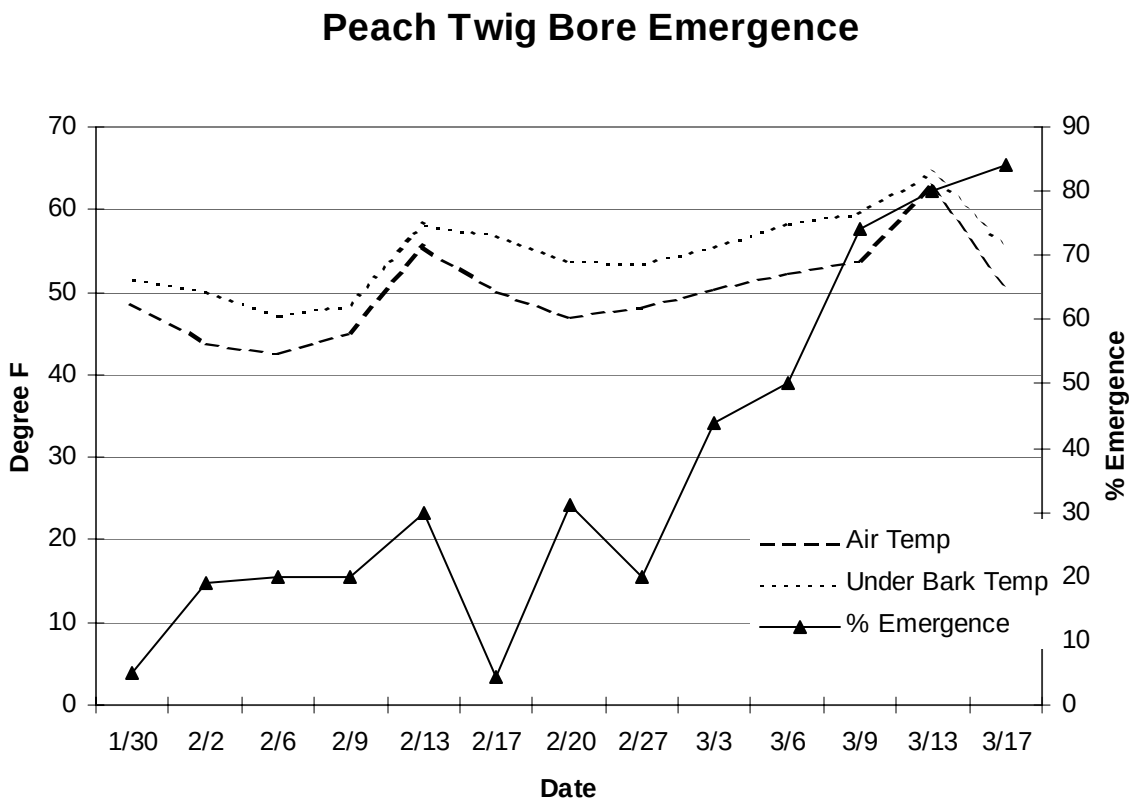
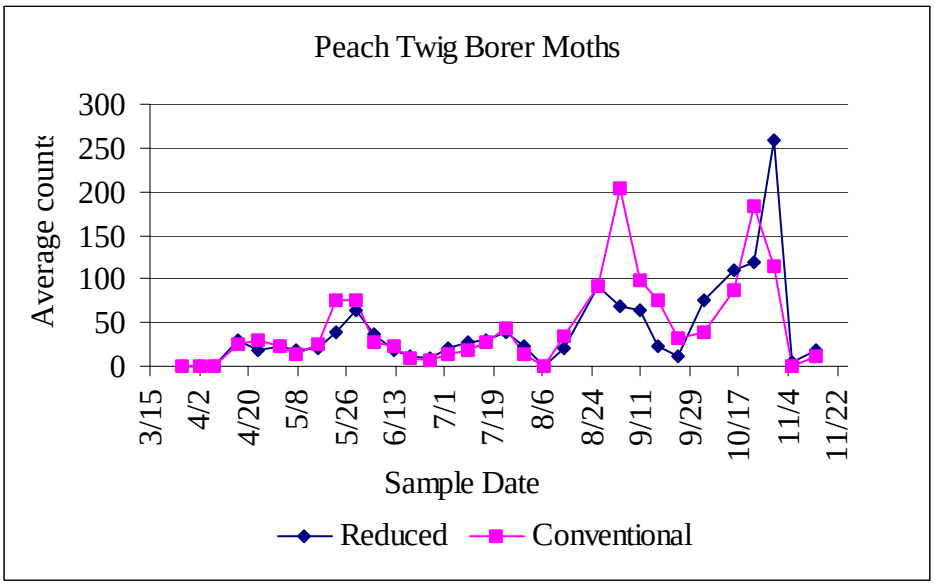
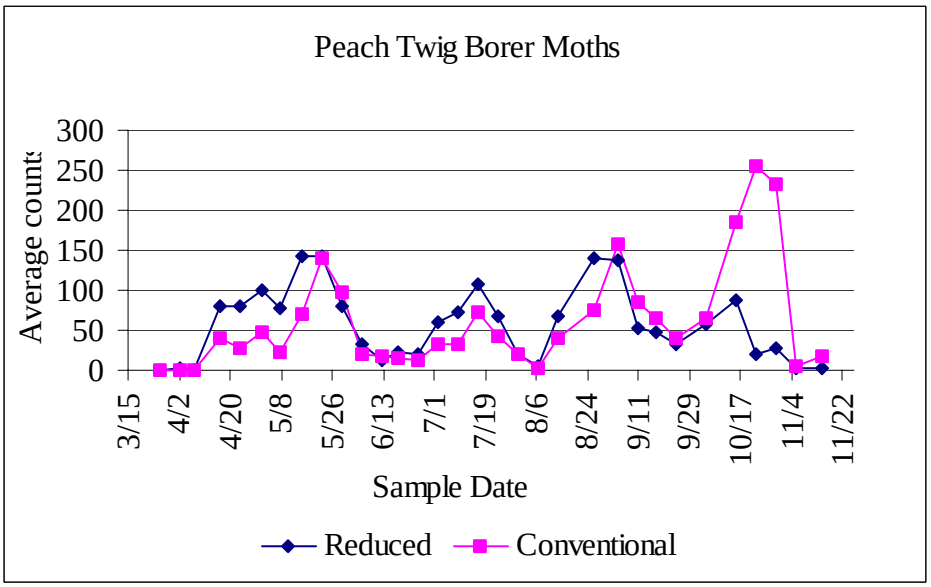


Figure 3 shows the PTB moth population from reduced and conventional treatments where dormant and no dormant sprays were applied. The moth population was lower in the no dormant treatment than on the dormant treatment. This was especially true early in the season. In August 24 both show a definite peak and another peak appears in October 17. The late season increase in population may explain the high reject level of late maturing varieties.

Figure 3. Average number of PTB moths per trap from reduced and conventional treatments where dormant and no dormant sprays were applied.



No Dormant Spray



Dormant Spray

Table 2 shows the number of strikes in June. The number of strikes was very low in the orchard. At this level one should not expect much nut meat damage. The reduced input plus oil in the dormant spray had the highest number of strikes. However, both the conventional sprayed with Diazinon® plus oil and conventional with no spray had the same number of strikes per tree. This means that Diazinon® and oil did not reduce the number of PTB strikes per tree.

Table 2. Average number of PTB strikes per tree from different dormant treatment in both conventional and reduced.

Management	Dormant Treatment	Average Strikes per tree

Conventional	Diazinon + Oil	0.4
Conventional	No treatment	0.4
Reduced Input	Oil only	2.4
Reduced Input	No treatment	0.9

The percent of rejects due to PTB is shown in Table 3. The reject level in Nonpareil was below one percent and it was zero for Butte for all management systems. This means that Diazinon® and oil had no effect in reducing nut meat damage.

Table 3. Percent of rejects due to Peach Twig Borer in Nonpareil and Butte under different management systems.

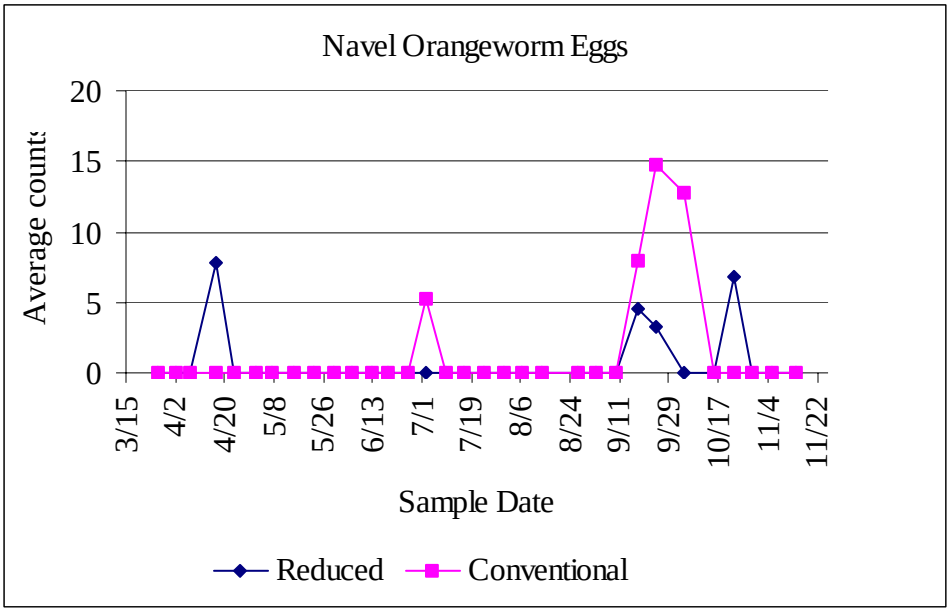
Management	Nonpareil					Butte				
	1999	2000	2001	2002	2003	1999	2000	2001	2002	2003
Reduced Input (Oil)	0.06	5.88	0.69	0.00	0.20	-----	8.49	0.19	0.13	0.00
Conventional (Oil + OPs)	0.26	4.40	0.00	0.00	0.80	-----	9.11	0.00	0.00	0.00
Reduced Input No Sprays	-----	-----	0.25	0.00	0.20	-----	-----	0.00	0.13	0.00
Conventional No Sprays	-----	-----	0.13	0.00	0.30	-----	-----	0.06	0.00	0.00

Navel Orange Worm (NOW). Mummy counts showed that both conventional and reduced input had less than one mummy per tree by February 12.

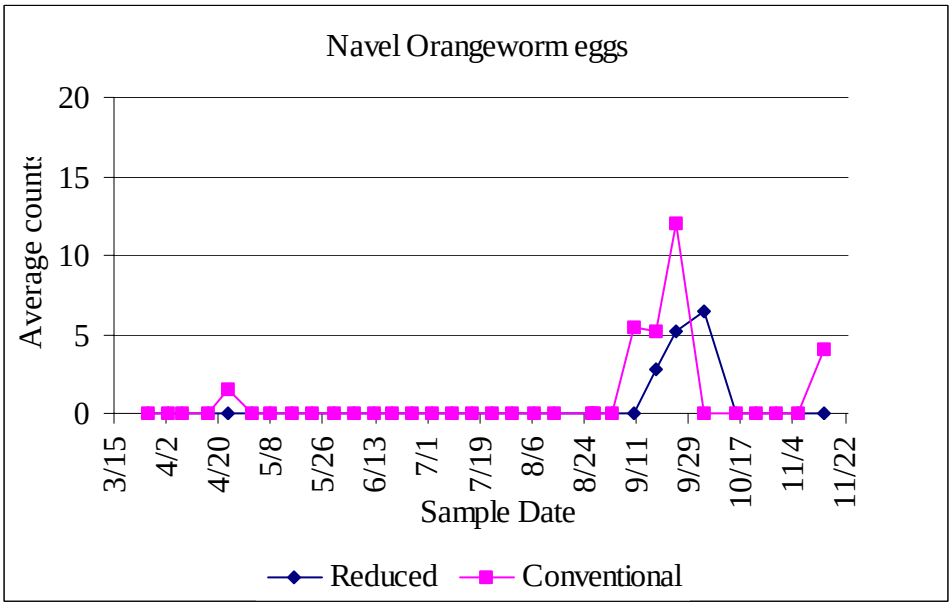
The average number of NOW eggs per trap from conventional and reduced input were very low in both dormant and non-dormant treatments early in the season. No major peaks were detected until early September. The no dormant conventional treatment had Imidan® at hull split. The dormant spray conventional had a Diazinon® at dormant and a Imidan® at hull split. Over all there were less eggs on the dormant spray treatment than on the non-dormant spray. The third generation peaks (late august early September) were about the same. However, the eggs in the conventional treatments peaked at a higher level.

This year growers complained about the high reject levels of the late maturing almond varieties. This may be due to the third generation peak which coincide with the hull split of these varieties.

Figure 4. Average number of NOW eggs from reduced input and conventional treatments where dormant and non-dormant treatments were applied.



No Dormant Spray



Dormant Spray

NOW rejects can be found in Table 4. The reject levels of Nonpareil in 2003 were very similar to the reject levels of 2002. The highest one was 1.13% which occurred in the non-dormant spray (no Diazinon®) and no hull split spray. The conventional (Diazinon® in dormant and Imidan® at hull split) had a 0.90% reject level. This means that the conventional only gave us a 20% control. The reject levels of Butte were below one percent. The reject levels in the conventional treatment were higher than on the reduced inputs.

Table 4. Percent of rejects due to NOW damage in Nonpareil and Butte under different management systems.

Management	Nonpareil					Butte				
	1999	2000	2001	2002	2003	1999	2000	2001	2002	2003
Reduced Input (Oil)	0.12	2.09	0.94	1.13	1.00	-----	7.99	1.00	0.00	0.50
Conventional (Oil + OPs)	0.19	2.81	0.14	0.25	0.90	-----	9.32	1.19	0.25	0.88
Reduced Input (No Sprays)	-----	-----	0.50	0.75	1.13	-----	-----	1.19	0.25	0.50
Conventional (No Sprays)	-----	-----	0.44	1.00	0.50	-----	-----	0.88	0.29	0.19

Mites. The 2003 season was a mite year due to the high temperatures in June. The mites were kept under control with predatory mite releases, Agri-Mek® sprays and oil sprays. Table 5 contains the different mite spray treatments that were required to control the mites this year.

Table 5. Management treatments for the control of mites in 2003.

Management	Spray Program
Conventional were	Agri-Mek® @ 10.0 oz. & 1% oil per acre in 200 gallons of water sprayed 4/30 & 6/11. Then 2% oil was sprayed July 2.
Reduced Input then a was	Predatory mites releases @ 2500 mites per acre on 5/13 and 6/5, 2% oil was sprayed every-other-middle. In addition, a 2% oil spray required on July 2.
Reduced Input were 5.	Agri-Mek® @ 10.1 oz. & 1% oil per acre in 200 gallons of water sprayed May 13. Then 2% oil was sprayed every-other-middle June A 2% oil spray was required on July 2.

All these spray programs controlled mites. However, from them we can conclude the following: 1) An Agri-Mek® spray can be saved, if one waits until mites are present. However, one should not wait past May 15 to apply it. Past this date Agri-Mek® may not be effective. 2) Predatory mite releases can be used to manage mite resistance and 3) Oil sprays (up to 2%) can control mites as long as sixspotted thrips are present in the orchard.

The average number of overwintering female mites are found on Table 6. The two reduced input treatments have a greater number of overwintering female mites than any other management system. When the movement of mites from the orchard floor to the tree scaffolds was evaluated by twig samples, no movement was detected from any of the treatments.

Table 6. Average number of overwintering female mites in each sampling date.

	D A T E S						
Treatment	**2/10**	**2/19**	**2/27**	**3/5**	**3/12**	**3/19**	**3/26**
Reduced Input (Oil)	1.30	0.80	0.10	0.15	0	12.3	0
Reduced Input (No Dormant)	1.10	0.10	0.20	5.60	2.30	10.40	2.15
Conventional (Dormant)	0.35	0	0	0	0	0	0
Conventional (No Dormant)	0	0	0	0	0	0	0

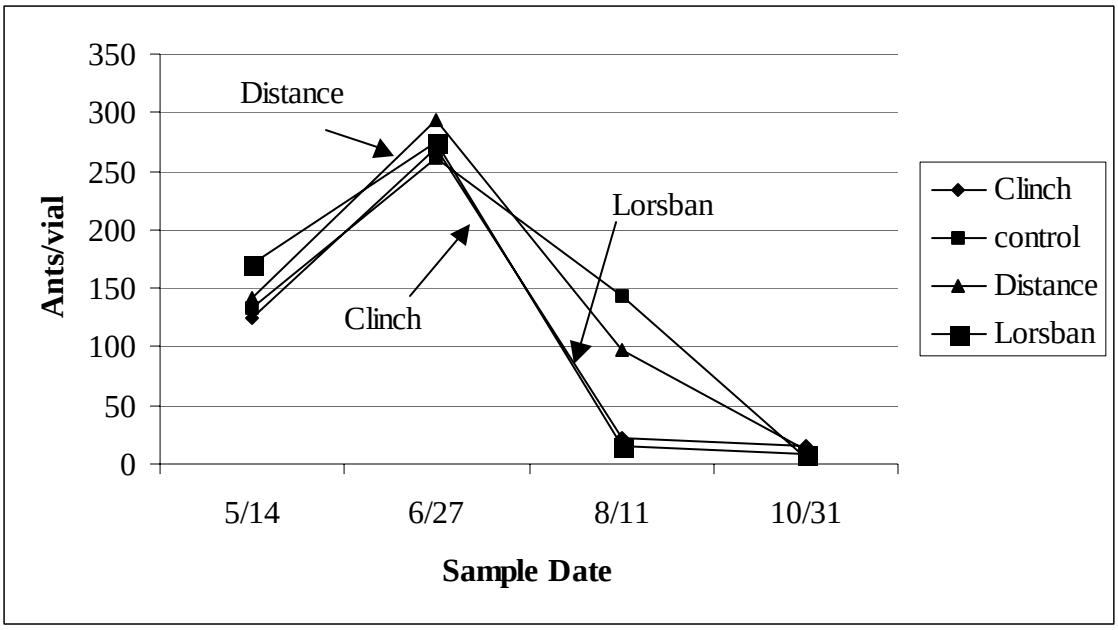
Ants. This insect can cause more damage to almond meats than NOW and PTB. Orchards that are harvested early and/or have a good cover crop or resident vegetation are most susceptible to ant damage. The ant treatments can be found in Table 7.

Table 7. Ant treatments for 2003.

Treatment	**Rate**	**Application Date**
Lorsban®	4 pints per acre	July 27
Clinch®	1.0 pounds/acre	July 9
Distance®	1.5 pounds/acre	June 19
control	untreated	

The ant population (ants per vial) can be found in Figure 5. There were no differences in the ant population due to treatment. The population in all treatments decreased in June 27. This corresponds to the 100^{o}F temperatures that occurred in the last week of June. This is not unusual. It has happened in the past.

Figure 5. Average number of ants from each sampling date.



The reject levels due to ants are found in Table 7. Clinch® and Distance® didn't provide a good ant control. Lorsban® appears to be a better choice. However, it was not better than the control. Ants have been the most difficult pest to control in the PMA orchard. The reasons may be due to the barley cover crop and the timing of the applications of both Clinch® and Distance®. Temperatures may play a role. When temperatures are high ants don't forage. This will make bait materials, such as Clinch and Distance ineffective.

Table 8. Percent damage due to ants from four different treatments.

Treatment	Percent Damage
Clinch®	2.50
Distance®	2.90
Lorsban®	1.56
control	1.48

Shell Seal. We have been evaluating shell seal in the PMA orchard. In 2002 there were no differences in shell seal and crop load. This year shell seal was evaluated on Nonpareil and Butte under the different management systems. The data is found in Table 9.

Table 9. Percent of open shell seal in 2002 for Nonpareil and 2003 for Nonpareil and Butte under different Management Treatments.

Management	2002	2003	
	Nonpareil	Nonpareil	Butte
Reduced Input	81	65	59
Conventional	81	74	49
Reduced Input-No Dormant	83	71	61
Conventional-No Dormant	83	78	52

Yields. The yield date is found in Table 10. The Nonpareil yields were affected by the management system. The lower yield was on the reduced inputs, where oil and no spray was applied in the dormant season for SJS control. This may indicate that SJS can have a major impact on yields. The yields on the Butte variety however, were not impacted by the management system.

Table 10. Yields (pounds per acre) of Nonpareil and Butte under different Management Systems.

Management	Varieties	
	Nonpareil	Butte
Reduced Inputs	2473 ab	3321 a
Conventional	2748 bc	3397 a
Reduced Inputs-No Dormant	2393 a	3325 a
Conventional-No Dormant	2795 c	3437 a

The Fritz variety showed severe spur and shoot die back in the reduced input with no dormant spray. The yield data on Table 11 strongly suggests that SJS has a major impact on yields.

Table 11. Fritz' yields (meat pounds per acre) due to SJS treatments.

Treatment	Yields
Oil & Sieze® - Dormant	2964
Sieze® - May spray	2990
Oil – Dormant	2565
Oil & Diazinon® - Dormant	2626
Untreated control	2655

Conclusions:

1. Monitoring is essential for pest management.
2. San Jose Scale is a key pest in almonds. It is very difficult to manage it, when inseason organophosphates are applied in the orchard. It is a pest that can decrease yields. This year the yields of both Nonpareil and Fritz decreased due to SJS. The best way to assess SJS infestation in an orchard is by determining infestation of spurs and shoots. SJS adult trapping only determines its presence.
3. The dormant spray (Diazinon® and oil) didn't appear to control Peach Twig Borer strikes nor did it appear to have any impact on reject levels.
4. NOW egg traps showed a definite increase in number of eggs in early September. This may explain high reject levels in late maturing varieties in Kern County. Hull split spray (Imidan®) resulted in a 20% reduction in NOW damage.
5. Predatory mites can be used to manage mite resistance to mitecides. Also they can control mites provided the orchard is heavily monitored. Oil sprays can be effective in controlling mites provided that sixspotted thrips are present in the orchard.

6. It has been difficult to control ants in the PMA orchard. This may be due to the barley cover crop or due to the high temperatures in late spring which may have interfered with ant's foraging behavior.

Acknowledgements

We wish to thank Thomas Vetsch of Vetsch Farms of California, Inc. for providing and maintaining the study site, and for providing labor when needed. We appreciate the donation of predatory mites by Matt Billings of Sterling Nursery, and Clinch® and financial support from Syngenta. This study was supported by a grant from the California Almond Board Pest Management Alliance. Thank you for your support.

Task 4: Stanislaus County Almond Pest Management Alliance Project
2003 Final Report

Roger Duncan, UCCE Farm Advisor, Stanislaus County; **Walt Bentley**, IPM Advisor, UC Kearney Agricultural Center, Parlier; **Merlyn Garber**, grower; **Art Bowman**, PCA, Salida Ag Chem.

Objectives of the Stanislaus County Almond Pest Management Alliance project:

- To scientifically evaluate the long-term effectiveness and economic viability of less broadly toxic pest management programs.
- To extend research-based information to the almond industry.
- To demonstrate IPM monitoring techniques and decision-making processes to local growers.

We have completed our fifth and final season in the Stanislaus County PMA trial. The original three pest management regimes were maintained similarly to the first two years (grower's standard practice and two "reduced risk" treatments). Because reject levels were very low for all pest management regimes, a fourth, "untreated" program was added in 2001. Each pest management program is replicated three times within a 120 acre Nonpareil orchard west of Modesto. Each plot is approximately 13.5 acres in size. The treatments are:

1) ***Grower's Standard Practice***: (fairly common in the Northern San Joaquin Valley).
- A **dormant** application of **Asana**® (a pyrethroid), 6 gallons of **oil**, & 8 lb. **Kocide**®.
- A **May spray** with an organophosphate (**Lorsban**).
- **Lorsban** for **ant** control.

2) ***Soft Program #1***:
- A **dormant** application of **copper & oil** (no insecticide).
- A "**bloom" spray of Confirm**® at ~ 30% PTB emergence (piggy-backed with fungicides).
- A **May spray** of **Success**®.
- **Clinch**® (Abamectin) bait for **ants** if monitoring deems necessary**.**

3) ***Soft program #2:***
- A **dormant** application with **oil** only.
- Two **"bloom"** applications of **Bt** (@ ~20% PTB emergence & ~ 80% emergence).
- Two **May sprays** of **Bt** (300-350 & 450-500 DD after biofix).
- **Esteem**® bait for **ants** if monitoring deems necessary.

4) ***"Untreated":*** only mites and ants are controlled if necessary.
- No dormant copper, oil, or insecticide application.
- No bloom insecticide applications.
- No May or hull split sprays.
- **Esteem**® bait for **ants** if monitoring deems necessary.

Overwintering nuts ("mummies") were removed and destroyed in all treatments to reduce overwintering naval orangeworm. Cover crop management, fertilization, and fungicide

treatments were the same for all treatments other than no dormant copper was applied in "soft program #2" and the "untreated" areas.

Monitoring:

Each plot had two PTB pheromone traps, two San Jose Scale pheromone traps, and two NOW egg traps. Peach twig borer and naval orangeworm traps were checked twice weekly while San Jose scale pheromone traps were monitored bi-weekly throughout the season (March through September). In addition, mites and mite predators were monitored bi-weekly with the presence / absence leaf sampling technique. In the fall, spurs were sampled to monitor San Jose scale populations.

Results:

PTB. For the first time in this trial there were more peach twig borer moths caught in the untreated areas than in treated areas (Fig. 1). Untreated areas had 28% more male PTB moths caught than the standard treatment (627 moths and 491 moths, respectively). The largest difference in moth catches occurred in the last flight which peaked after the Nonpareil had been harvested (Fig. 2). There were no differences in PTB caught between the standard treated areas and the two "reduced risk" pesticide treated areas.

Fig. 1. Season Total of Peach Twig Borer Moths Caught in Each Treatment.
Stanislaus County PMA Trial, 2003.

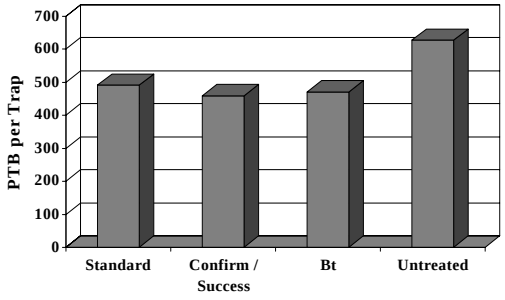
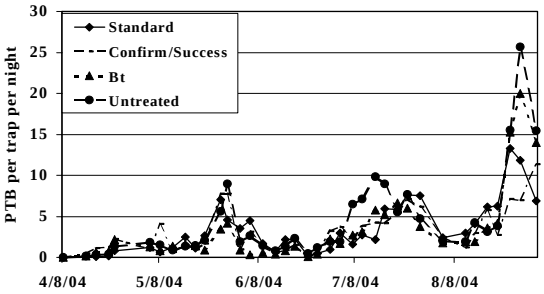


Fig. 2. PTB Moth Flights as Influenced by Pesticide Program.
Stanislaus County PMA Trial, 2003



San Jose scale. Once again, San Jose scale populations were very low in 2003 in all treatments (Fig. 3). In addition, scale parasites were again much lower in the areas treated with the grower's standard insecticide program compared to untreated areas. For unknown reasons, the areas treated with Success and Confirm had lower scale parasites than the Bt-treated and untreated areas in 2003. The ratios of scale parasites to San Jose scale were again very high in the untreated areas and the Bt-treated areas. For the first time in this trial San Jose scale was found on fall-sampled spurs. Scale were only found in the untreated areas. Numbers were well below the treatment threshold.

For reasons unknown, Encarsia numbers have declined substantially in all treatments during the five years of this trial (Fig. 4). In 2003, Encarsia numbers were extremely low with only about 25 wasps caught on average in the grower's standard treatment. Aphytis was the most commonly recovered scale parasite.

Fig. 3. Cumulative Total of San Jose Scale & Scale Parasites as Related to Treatment

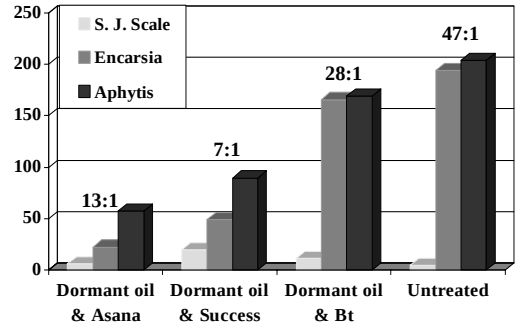
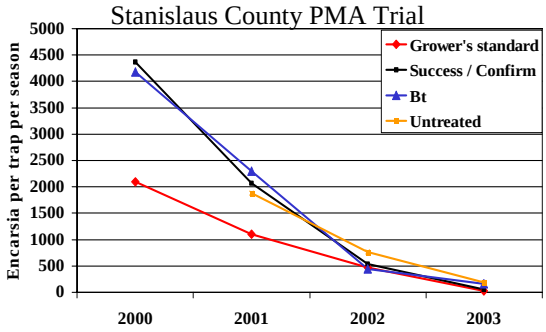


Fig. 4. Seasonal Totals of *Encarsia* from 2000 - 2003



NOW, ants and spider mites. Almost no navel orangeworm eggs were found on traps in any treatment. The grower did a great job with orchard sanitation and therefore reduced overwintering NOW populations. There were no differences among treatments in web spinning mite populations according to the presence / absence sampling technique. Mite numbers stayed well below treatment thresholds in all areas. Ants were not monitored in 2003 and no treatments were applied for ant control.

Insect Damage at Harvest. Three hundred nut samples were collected from windrows at harvest in each plot (total of 900 nuts per treatment). Nuts were cracked by hand and examined for feeding damage by navel orangeworm, peach twig borer and ants (Table 1). Overall insect damage was very low and there were no significant differences among treatments.

Table 1. Harvest Rejects Due to Insect Feeding On Nonpareil Almonds. Stanislaus County PMA Trial, 2003.

	% NOW	% PTB	% Ant	Total % Rejects Due to Insects
Grower's Standard	0	0.1	0	0.1
Success / Confirm	0	0	0.6	0.6

Bt	0	0	0.6	0.6
Untreated	0	0.1	0.6	0.7

Treatment costs. Although there was no difference in pest pressure or insect feeding damage at harvest among treatments, there was a significant cost difference (Table 2). The Confirm / Success treatment cost an extra $21.70 per acre. The Bt treatment cost an additional $37.10 per acre. From an economic view point, there is no incentive for growers to use reduced risk materials like Success, Confirm or Bt. If a grower needs to apply a dormant oil for scale control, it makes better economic sense to apply something for PTB at that time. If a dormant oil spray for scale is not necessary, a grower may choose to apply one of these reduced risk materials at bloom for PTB if necessary. Of course the least expensive program is one where no insecticide is applied. However, few growers may choose to take that risk.

Table 2. Costs Per Planted Acre.

Stanislaus County Almond PMA Project, 2003

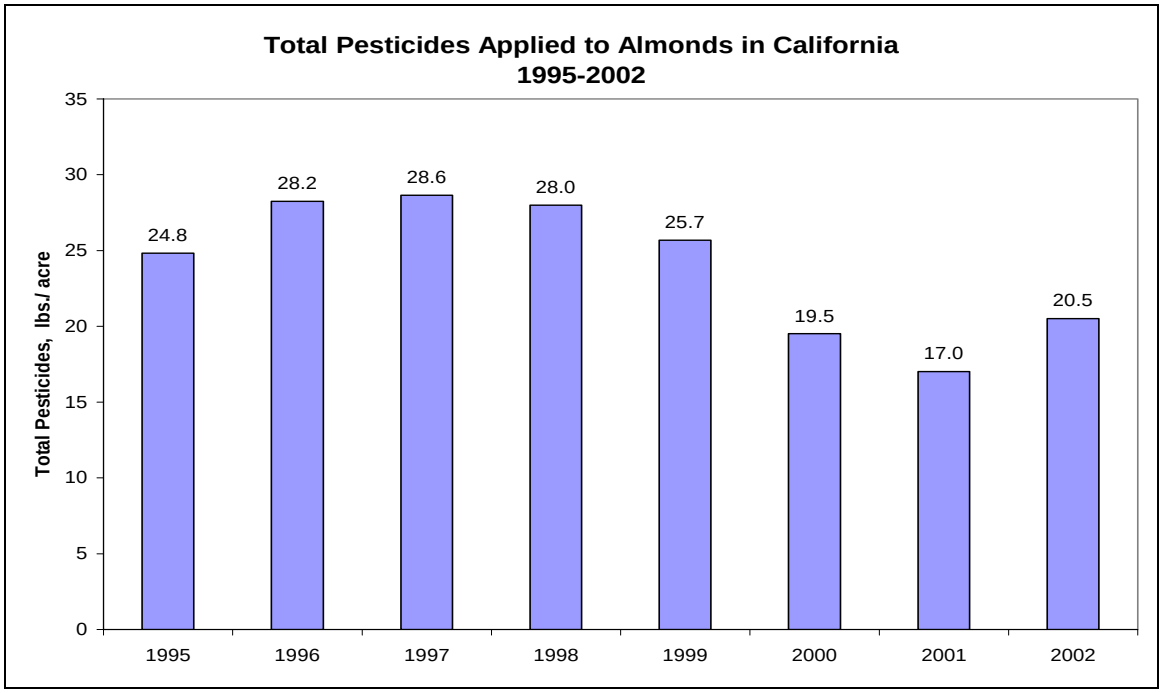
(Includes $13.65 per acre application costs.)

Pesticide Program	Spray Timing	2003
Grower's Standard	Dormant	$57.98
	May	$33.77
	Total	***$91.75***
Confirm/ Success	Dormant	$50.65
	Bloom	$25.77
	May	$37.07
	Total	***$113.45***
Bt	Dormant	$31.05
	Bloom	$48.90*
	May	$48.90
	Total	***$128.85****
Unsprayed	***Total***	***$0.00***

*Bt application timing did not coincide with fungicide bloom sprays in 2003. Therefore an additional application cost of $13.65 is included.

TASK 5: PESTICIDE USE

The Almond PMA's five years of successful reduced risk research and demonstration illustrate that almonds can be grown using a "soft" pest management program without additional damage to the crop. According to Pesticide use reports accessed at the California Department of Pesticide Regulation website, http://www.cdpr.ca.gov/docs/pur/, pesticide use in California almonds continues in a general decline since a high in 1997 of 28.6 lbs/ac total pesticides. During the five years of the Almond PMA (1999-2003), the California almond industry has reduced its annual use of pesticides by almost 3 million pounds, which is a 20% reduction in pounds applied/acre, showing a true commitment by the Almond industry, the University, and the almond growers. It is likely that the PMA's outreach and education efforts have had an impact, helping to decrease reliance on pesticides.



In previous years, Task 5 of the PMA has included an analysis of the Pesticide Use Reports, summarizing the use of organophosphates, carbamates, pyrethroids, and Bt on almonds, both statewide and in the counties with PMA sites, Butte, Kern, and Stanislaus. This report will not include that information, as a much more detailed analysis will soon be directly available California DPR. The following two reports, not yet released, include a much more detailed statistical analysis of the Pesticide Use Reports than the PMA is capable of.

1. **Dormant Season Organophosphate Use in California Almonds,** by Minghua Zhang, Larry Wilhoit, and Chris Geiger

2. **Pest Management Assessment for Almonds: Reduced-Risk Alternatives to Dormant Organophosphate Insecticides**, Prepared by Bob Elliott, Larry Wilhoit, Madeline Brattesani, and Nan Gorder, January 2004

Task 6: Education, Outreach, and Extension

Education, outreach, and the extension of information are the basis for California almond growers to gain confidence in reduced risk practices. Conducting field meetings, workshops, and providing information via newsletters, status reports, and articles play an important role. In addition, the Almond PMA is drafting monitoring guidelines for PTB, NOW, SJS, mites, ants, and dormant sampling. These protocols are a work in progress; however other groups and individuals have already expressed an interest in using them.

Attendance at field day meetings reflects the optimism and success the PMA program. Each region organizes at least two meetings per year. One meeting is conducted in the spring and the other is a dormant/winter meeting. Meetings and seminars with a focus on dormant season information are an important part in the extension of information demonstrating techniques helpful in reducing pesticide inputs. The winter meetings coincide with the time of the season where many insecticidal sprays are being applied and therefore are especially relevant for growers and PCA's to help determine whether an orchard requires any dormant treatment. At the beginning of the 2003 season, Butte County held a meeting on January 9, and Stanislaus County had one on January 29. Both of these meetings highlight ongoing research towards almond production using reduced risk practices, and include information specific to each region's pest pressures. The most recent dormant meetings have been at the end of the 2003 crop year. These have had an emphasis on proposed regulation changes regarding irrigation discharges and dormant season applications. Kern County's meeting was on November 25, 2003, and Butte County's on December 11.

The PMA sites also hold field meetings during the summer months with pest management demonstrations and hands-on displays. These meetings are very valuable and are usually very well attended because they show first hand the successes of the reduced risk treatments and the grower is available to talk about his experiences in the project. Less toxic alternatives to traditional in-season insecticides are explained as well as insect identification and using weather data to time sprays and forecast insect population peaks. The spring Field Days were held in Kern on May 1, in Stanislaus on May 15, and in Butte County on May 20, 2003. Topics included increased diseases seen in 2003, almond replant disease, rootstock evaluation, deficit irrigation, degree day projections, insect monitoring, nutrition and tissue sampling, and updates on laws and regulations from the Agricultural Commissioners office. In addition, the almond PMA was highlighted in a presentation by Carolyn Pickel at the Nickels Field Day in Arbuckle on May 8, 2003.

Newsletters are an important component for relaying updates and informing growers, some who may not be active in the PMA, on issues regarding almonds in California.

Many of these newsletters are regional, thereby relaying pertinent information to local growers. Some newsletters are sent via mail, others are status reports or quarterly reports reported to the Department of Pesticide Regulation that can be accessed via the Almond PMA website at http://lookercomm.com/almondPMA/almondpma.htm. News articles and news coverage relating to the Almond Pest Management Alliance benefit the program by reaching a large audience in popular agricultural periodicals. The winter 2002-2003 Almond PMA Newsletter was sent to 6,500 growers, PCA's and other interested parties. It contained updates on the regional projects and detailed information on shredding and chipping almond prunings to help air quality. The Fall-Winter 2003 issue of the newsletter focused on the unusually high level of damage to the crop at the Butte site, and also detailed new grant funds that will keep the project going a while longer. The newsletters are also posted to the Almond PMA website.

Many growers and those involved with the almond industry subscribe to or have access to agricultural periodicals. The Almond PMA makes good use of this medium for educating and updating many of those growers who do not actively participate in the Almond PMA. Through this extensive outreach effort, we hope to gain interest in the program, thereby increasing the numbers of growers voluntarily adopting reduced risk techniques in some capacity.

Articles in Ag Alert, the California Farm Bureau's newsletter, on April 10 and May 14, 2003 provide detailed information about San Jose scale and Tenlined June beetle problems in Stanislaus County and statewide. The Modesto Bee, October 14, carried a story about the success of almond growers working to reduce the use of pesticides, highlighting the PMA's emphasis on proactive use of more environmentally sensitive pest management. Also in October, the EPA announced new funding awarded to the almond industry to reduce pesticides, with praise to the industry and the PMA for the decreased pesticide use since 1997.

DISCUSSION

A renewed interest in farming with more sustainable practices due to the possible risks to water quality from some dormant sprays, increasing incidents of documentation of resistance to the most commonly used insecticides, and the impending loss of traditional crop protection tools due to FQPA implementation increases the need for proven alternative pest management methodology.

The 3 regional PMA sites are an excellent demonstration that reduced risk programs using lower inputs of organophosphate and carbamate pesticides have had no more damage than the conventional methods of growing almonds, which sometimes use two or more sprays of pesticides. The 5-year continuation of the regional demonstrations created an extensive database of information about reduced risk scenarios that will be very valuable to almond growers. The monitoring performed at each site remained similar for statistical purposes, and to increase the validity of comparisons between the different almond growing regions of California, and the comparisons between crop years.

The continuation of this project for multiple years brought to light some important lessons. The primary lesson being that it is possible to produce almonds with very low chemical inputs. The data repeatedly showed that increased applications of pesticides do not necessarily correlate with better yields. However, in 2003 only, pest pressures increased in some areas, resulting in increased harvest damage in some plots that had little or no pesticide applications. This proves the critical importance of ongoing monitoring as well as the importance of adherence to accurate treatment thresholds. It is still unclear whether the increased damage in 2003 was a result of unusual weather patterns, or natural fluctuations in insect populations, or whether secondary pest pressures increase when broad-spectrum pesticides are no longer routinely applied. All of this also shows that there is still much to learn from continuation of this type of research and funding opportunities should continue to be explored.

The possibility of continuation of a closely related project brought to light the second important lesson from the almond PMA. That is, the almond growing regions of California (Northern, Central, and Southern), each have specific and differing pest pressures. Examples can be taken directly from the 3 demonstration plots. Kern and Stanislaus Counties showed high pressure from San Jose scale and mites when treatments were not applied. Also, due to lower winter rainfall in the region, Naval orangeworm control by winter sanitation requires extra effort in destroying mummies in Kern County. In Butte County, NOW control consists of removing mummies from the trees, and the higher rainfall and resident vegetation help the nut mummies to decompose without the extra steps of removing mummies from the tree rows and chopping to destroy them. Also, in Butte County, San Jose scale can be naturally controlled by beneficial insects if broad-spectrum insecticides are not applied. With this knowledge it becomes apparent that pest management guidelines for reduced risk systems must be region-specific.

The third lesson from this project is learned when an attempt is made to compare the costs of “reduced risk” pest management to “conventional” pest management. “Reduced risk” pest management can include the use of newer, more environmentally-friendly pest control materials, which are commonly more expensive than traditional pesticides. However, “reduced risk” can also include reducing inputs, meaning fewer applications or even zero. In an economic sense, the fewer trips through the orchard with the sprayer, the better. This is important to deflect the common conception that it is always more expensive to farm using “reduced risk” methods in order to reduce the detrimental impact on the environment.

It is clear the PMA has something important to offer the agricultural community. The Almond PMA has been recognized for its contribution to the decreasing reliance on pesticides to grow almonds and looked to for information about how to implement a reduced risk pest management system. This past year, the PMA received requests to share the monitoring protocols for reduced risk almond production. Although these protocols may not work for all systems, the Almond PMA has done much during the past five years to raise awareness of reduced risk farming practices among the almond growing industry, governmental regulatory agencies (such as the Environmental Protection Agency, the State Water Resources Control Board, the regional Water Quality

Control Boards, and the California Department of Pesticide Regulation), as well as the general public.

Project Summary Form 2003

1) Proposal Title

To Promote a Reduced-Risk System of Almond Production Through Alternative Practices

2) Principal Investigator

Chris Heintz**,** Director of Research, Technology, and Education, Almond Board of California

3) Alternative Practices

Monitoring with pheromone traps and degree-day models to time sprays. Releases of beneficial insects, and applications of Bt and insect growth regulators instead of OP pesticides. Survey of dormant spurs to determine need for dormant treatment. Predatory mites and oil sprays instead of miticide sprays. Cover crops planted to decrease runoff and increase water penetration. Winter sanitation to reduce need to spray for navel orangeworm.

4) Summary of Project Successes

In the 5 years of the almond PMA(1999-2003), growers have reduced pesticide use by 20%, even as planted acres increased. The PMA has demonstrated that a dormant insecticide is not always needed, and that often there is no additional crop damage with zero sprays. Meeting attendance is increasing as growers look to the PMA for guidance in the transition to reduced risk pest management.

5) Number of Participating Growers: 3

6) Total Acreage in Project: 329

7) Project Acreage Under Reduced Risk: 200

8) Total Acres of Project Crop: Approximately 1400

9) Non-Project Reduced Risk Acres: Approximately 900

10) Number of Participating PCA's: 2

11) Cost Assessment:

Reduced risk pest management materials tend to be more expensive than conventional sprays, such as organophosphates. However, reducing the number of pest control applications made the cost decrease; frequently the PMA plots with zero sprays had very little insect damage. Average pest management costs for reduced risk plots were $85/acre, and 'conventional' were $112/acre.

12) Number of Field Days: 6

13) Attendance at Field Days: 450-500

14) Number of Workshops & Meetings:
2 meetings of the Almond PMA Advisory Team

15) Workshop Attendance: 18

16) Number of Newsletters: 2

17) Number of Articles: 4 total.
The Almond PMA was featured in Ag Alert in April and May, 2003, and in the Modesto Bee in October. USDA issued a press release in October 2003 praising the PMA for its influence in the reduction of pesticide use.

18) Number of Presentations:
1 Presentation by Carolyn Pickel, at the Nickels Field Day in Arbuckle.

19) Other Outreach Activities:
Almond PMA Website at
http://www.lookercomm.com/AlmondPMA/almondPMA.htm

FOR OFFICIAL USE ONLY Contract Number Project ID
Contract Manager
25th June 2001 Version DPR ID#